

STATE COLLEGE OF WASHINGTON
AGRICULTURAL EXPERIMENT STATION
Pullman, Washington

Department of Horticulture

Peach Maturity at Harvest as Related
to Quality

by

O. M. Morris

Bulletin No. 266

July, 1932

All bulletins of this Station are sent free to citizens of the State
on application to the Director

BOARD OF REGENTS

J. H. Hulbert, President.....	Mount Vernon, Wash.
Walter R. Rowe.....	Naches, Wash.
A. W. Davis.....	Spokane, Wash.
F. J. Wilmer.....	Rosalia, Wash.
W. A. Ritz.....	Walla Walla, Wash.
E. O. Holland.....	(President of the College, Secretary, ex-officio)

EXPERIMENT STATION STAFF

E. O. Holland, Ph.D., President	Edward C. Johnson, M.A., Director
Wm. C. Kruegel, B.A., Treasurer	

Agricultural Engineering

L. J. Smith, M.E., Agricultural Engineer in Charge.
H. L. Garver, E.E., Investigator, Farm Electricity. ¹
P. C. McGrew, B.S., Agricultural Engineer, U.S.D.A. ²

Agronomy

E. G. Schafer, M.S., Agronomist in Charge.
E. F. Gaines, D.Sc., Cerealist. ³
A. L. Hafenrichter, Ph.D., Asst. in Farm Crops.
S. C. Vandecaveye, Ph.D., Soil Biologist.
L. C. Wheatling, Ph.D., Associate in Soils.
G. O. Baker, M.S., Assistant in Soils.
O. E. Barbee, M.S., Asst. in Farm Crops.
Orval A. Vogel, M.S., Agent, U. S. D. A. ²
H. P. Singleton, M.S., Associate in Agronomy, Irrigation Branch Station, Prosser.
Carl A. Larson, Ph.D., Specialist in Irrigation Investigations, Irrigation Branch Station, Prosser. ²
Harley Jacquot, B.S., Asst. in Agronomy, Adams Branch Station, Lind.
W. A. Rockie, B.S., Scientist in Soil Erosion, U. S. D. A. ²

Animal Husbandry

Howard Hackedorn, B.S., Animal Husbandman in Charge.
Jerry Sotola, M.S., Asst. Animal Husbandman.
G. B. Swier, M.S., Asst. in Animal Husbandry.
R. E. McCall, M.S., Asst. in Animal Husbandry.

Chemistry

J. L. St. John, Ph.D., Chemist in Charge.
Otto Johnson, M.S., Assistant Chemist.
Kermit Groves, Ph.D., Assistant Chemist.

Dairy Husbandry

E. V. Ellington, B.S., Dairy Husbandman in Charge.
H. A. Bendixen, M.S., Associate Dairy Husbandman. ²
C. C. Prouty, M.S., Associate Dairy Bacteriologist.
J. C. Knott, M.S., Superintendent Official Testing.
R. E. Hodgson, M.S., Assistant Dairy Husbandman, Western Washington Experiment Station, Puyallup. ²

Entomology & Zoology

R. L. Webster, Ph.D., Entomologist in Charge.
....., Asso.
Entomologist, Wenatchee.
Arthur J. Hanson, M.S., Assistant Entomologist, Western Washington Experiment Station, Puyallup.

Farm Management & Agricultural Economics

Rex E. Willard, B.S., Agric. Economist in Charge.
E. F. Dummeler, Ph.D., Agric. Economist.
Chester C. Hampson, M.A., Assistant Agricultural Economist.
E. F. Landerholm, M.S., Asst. in Farm Management.
A. A. Smick, M.A., Asst. in Rural Sociology.
Home Economics
Florence Harrison, A.M., Home Economist in Charge.
Evelyn H. Roberts, M.S., Research Specialist in Home Economics.
VeNona W. Swartz, M.S., Research Specialist in Foods and Nutrition.

Horticulture

E. L. Overholser, Ph.D., Horticulturist in Charge.
O. M. Morris, M.S., Horticulturist.
F. L. Overley, M.S., Associate in Horticulture, Wenatchee.
C. L. Vincent, M.S., Asst. Horticulturist.
L. L. Claypool, B.S., Asst. Horticulturist, Irrigation Branch Station, Prosser.
Kenneth A. McKenzie, M.S., Assistant in Horticulture, Wenatchee.
C. D. Schwartz, B.S., Research Assistant.

Plant Pathology

F. D. Heald, Ph.D., Plant Pathologist in Charge.
L. K. Jones, Ph.D., Assoc. Plant Pathologist.
C. S. Holton, Ph.D., Agent, U. S. D. A. ²

Poultry Husbandry

John S. Carver, B.S., Poultry Husbandman in Charge.
Donald Brazie, M.S., Asst. Poultry Husbandman.

Veterinary Science

J. W. Kalkus, D.V.S., Veterinarian in Charge, Western Wash. Exp. Station, Puyallup.
C. E. Sawyer, D.V.S., Research Veterinarian, Western Wash. Exp. Station, Puyallup.

Branch Stations

H. M. Wanser, M.S., Supt. Adams Branch Station, Lind.
H. P. Singleton, M.S., Superintendent, Irrigation Branch Station, Prosser.
D. J. Crowley, B.S., Specialist in Cranberry Investigations, Cranberry Investigations Laboratory, Long Beach.

Pacific Northwest Soil Erosion Station²

W. A. Rockie, B.S., Superintendent.
P. C. McGrew, B.S., Agricultural Engineer.

¹ In cooperation with the State Committee on the Relation of Electricity to Agriculture.

² In cooperation with the United States Department of Agriculture.

³ On leave.

TABLE OF CONTENTS

Introduction	5
The Problems	6
Market Demands	6
Selection of Experimental Material	6
Firmness	6
Shape	7
Adherence to stem	7
Color	7
Maturity of experimental lots	7
Tests of Early Crawford	8
Tests of Elberta	11
Tests of Elberta in 1926	11
Tests of Elberta in 1927	14
Tests of Elberta in 1928	15
Tests of Elberta in 1929	16
Tests of Elberta in 1930	17
Softening of Elberta Peaches	18
Tests of J. H. Hale	18
Tests of J. H. Hale in 1927	18
Tests of J. H. Hale in 1928	21
Tests of J. H. Hale in 1929	22
Tests of J. H. Hale in 1930	23
Softening of J. H. Hale	23
Minor Varieties	26
Storage Temperatures	26
Elberta Response to Storage Temperatures	27
Influence of Change of Storage Temperature	31
Change in Flavor	31
Variability of Fruit Color	31
Changes in Texture	32
Handling Quality	32
Summary	33
Acknowledgement	35
Literature Cited	35

PEACH MATURITY AT HARVEST AS RELATED TO QUALITY

O. M. Morris

Introduction

The peaches grown in the state of Washington are excellent in appearance, in size, and when tree ripened in quality. Many of those found in the fresh fruit markets, however, are of very poor quality. This fact has raised the question: can Washington peaches of high flavor be placed on the city markets in good condition?

Peach growers and workers in the peach harvest know that the highest quality fruit is that which is properly grown, well colored, and ripened on the tree. They have not been so well informed as to the quality of fruit harvested before proper maturity when it is placed before the consumer in distant markets.

A limited survey of markets brought out the fact that the average buyer of fresh fruit avoids material that shows dark spots indicative of deep bruises, over-ripe condition, or decay. Fruits of adequate size, good color, and normal shape are desirable, but these characteristics are of secondary importance compared to freedom from dark soft bruises.

In popular literature and discussions among growers and shippers, the proper state of maturity of peaches for picking is most frequently described as "hard ripe." Kantor (2) reported that condition and quality in peaches are recognized by buyers in the city of New York, and that these two factors have a great influence upon the price paid and the amount consumed each year. Bruised, over-ripe, and green fruit are among the commoner causes of low returns. Lloyd (3) found that rough handling in the picking operation is most often responsible for the bruised and bad condition of Illinois peaches examined in the market. The over-ripe peaches are generally badly bruised, but no clear lines of demarcation are made between "hard ripe" and "over-ripe."

The author (4) reported that recognizable degrees of maturity of fruit at harvest time existed, and that when fruit was picked sufficiently mature material of higher quality could be placed on the market. He also stated that a large per cent of the Washington peach crop was harvested too early for best quality and that the quality of material

placed on the markets varied from year to year. Duruz (6) stated that "peaches for eastern shipment should be 'hard ripe' at picking time. White-fleshed peaches should be in such a condition that they will have lost their deep green cast and should be turning from a green or light yellow to a creamy white color. Yellow-fleshed peaches when ready for picking should show the 'under color' changing from yellow to golden yellow." Lloyd (7) placed emphasis upon uniformity of size and freedom from blemishes. In the definition of grading terms, "firm" was described as meaning mature but not soft or over-ripe. "Mature" was defined as the stage of fruit development that insured the proper completion of the ripening process after harvest.

Blake (8) determined that the length of growing period between blossoming and ripening varied from year to year. Culpepper and Caldwell (9) presented data which showed that peaches change in chemical content during the last few days of growth. The sugar content increased and the acid content decreased.

The Problems

The problems to be studied were: To what extent was the low quality of fruit on the market related to the state of maturity at harvest? Can fruit sufficiently matured to have good flavor and appearance be shipped and retained for a sufficient length of time to be placed in markets more than a few hours distance from the point of production?

Market Demands

In a survey of the markets it was found that the fruit buyers and shippers generally held that fruit of extreme hardness was required for shipment. Only fruits so green and hard that they could be handled roughly without showing signs of bruises were considered suitable for market purposes.

Selection of Experimental Material

The standards used in the experimental work in determining the proper degree of maturity for picking were as follows: firmness, color, and shape of fruit, and ease of separation from the stem.

Firmness. Firmness of the fruit was measured by a mechanical pressure tester described by Magness and Taylor (10). This machine is now in common use in the federal and state inspection service. A plunger, five-sixteenths of an inch in diameter, was pressed into the unpeeled fruit about three-eighths of an inch. It was of value in determining the appearance of fruit in different stages of maturity. It was of relatively little value as a guide for harvest since most workmen could tell by the pressure of the thumb or hand the approximate hardness of the fruit and could thus judge closely enough for practical purposes in fruit harvest.

Shape. The shape of the fruit could be used as a gauge of maturity in some orchards but not in others. In orchards subjected to only slight variations in growth conditions during the growing and harvesting season, it was found that the fruit quite uniformly assumed typical shape at full maturity. In other orchards the fruit varied greatly in form during the harvest season.

Adherence to Stem. The ease of separation of the fruit from the stem was found to be unreliable as a guide in determining degree of maturity. With fruit left on the tree until almost ripe, many stems would pull loose from the tree before separating from the fruit, while the greenest fruits harvested would often separate from the stem or from the twig as easily as the fruit of approximately complete growth and maturity. Tests were made in orchards at Wawawai, Kennewick, and Yakima. The Elberta picked with a straight pull of less than 1½ pounds gave pressure tests of 1 to 9 pounds; those picked with a straight pull of 2 to 4 pounds gave pressure tests of 6 to 30 pounds. Fruits picked by pulling at a right angle from the direction of the stem gave a much greater variation in pressure test in the different lots. Tests were made on J. H. Hale and Early Crawford with similar results. The state of vigor of the tree seemed to influence the tenacity with which the fruit adhered to the stem. This method of gauging maturity was discarded after the second season's work.

Color. Complete and detailed description of color were made in 1926 and for part of the 1927 harvest. It was found to be impractical and almost impossible to describe minutely the differences in color that were observed. Four lots or classes were formed by arbitrary lines of color description and used throughout the experiment.

Maturity of experimental lots. The peaches in the commercial packing sheds were in many places carefully examined, and it was found that they could be classed roughly in four stages of maturity. The lines of distinction between these lots, however, were not clear cut as fruits of all stages of maturity from green to ripe were found in every packing table. The classes overlapped in every measurement of maturity that was applied so that only arbitrary lines, such as the color classification used, seemed to be possible of application.

What have been called Lots 1 to 4 through this series of tests, generally described with respect to maturity, are as follows:

Lot 1: Ground color of fruit, yellow shading to light orange around the crimson cheek or exposed side; firm but not hard; pressure test 7 to 18 pounds. This lot contained the most mature fruits.

Lot 2: Ground color greenish yellow, changing to deep yellow on the exposed side of the fruit, overshaded with light carmine; pressure test 14 to 22 pounds.

Lot 3: Ground color green, shading to light yellow or straw yellow on the most exposed side, sometimes overshadowed with light red; pressure test 22 to 29 pounds.

Lot 4: Ground color green, shading to yellowish green or light greenish yellow on the most exposed side of the fruit; pressure test 24 to 32 pounds. This lot contained fruit harvested in the most immature stage.

These color standards with slight modifications were found about equally applicable to J. H. Hale, Elberta, Early Crawford, Late Crawford, Rochester, and Gold Medal varieties. Early Elberta in no lot examined attained quite as high color as the color standards given.

There was a great variation in the degree of maturity set as standards by the orchard foremen. Elberta peaches harvested in five different commercial orchards were sorted into the maturity lots previously described. The per cent of harvested fruit which upon the basis of maturity was placed in each lot was as follows:

Orchard	Lot 1	Lot 2	Lot 3	Lot 4
No. 1	10%	23%	45%	20%
No. 2	5%	15%	50%	30%
No. 3	35%	55%	10%	0
No. 4	0	20%	41%	39%
No. 5	0	5%	47%	48%

Samples were purchased from commercial orchard harvests each year from 1926 to 1930 inclusive. Each sample consisted of 10 or more boxes¹ of fruit containing not less than 600 peaches. The fruit was sorted into lots conforming as nearly as possible to the previous description of color, and stored. Some lots were placed in cold storage; others were precooled, shipped to Pullman and then restored; others were shipped direct from the packing shed to Pullman and stored at various definite temperatures. Representative data obtained from these lots are given in Tables 1 to 3.

Tests of Early Crawford

The Early Crawford is an early, yellow, red cheeked peach of good quality. The flesh is bright yellow and medium firm to soft. It does not withstand shipping and storage so well as the Elberta. Its earliness and good quality are its chief merits as a commercial peach.

The peaches of Table 1 were harvested at Wawawai, Washington, July 27, 1926. The trees from which the fruit was gathered were about 15 years old and in good vigor. The soil, a fertile deep sandy loam, was well irrigated and the trees were in good condition.

¹All the fruit except one small shipment was wrapped in commercial fruit wrap paper and packed in the standard peach boxes for shipment and storage. This box is 11.5 in. wide, 18.5 in. long and 4.5 in. deep, inside measurements.

The fruit was of medium to large size, of good form, color, and flavor. It was picked and packed in the morning and put in storage before four o'clock in the afternoon. A large proportion of the crop was picked very green.

After 10 days storage at 33° F. the change of color was very slight in the more mature fruit (Lots 1 and 2) and no change could be seen in the less mature fruit (Lots 3 and 4). The fruits in Lot 1 were edible or in good condition for canning. These fruits, as in the tree ripened fruits, were softest along the suture line.

Table 1. Quality and Storage Capacity of Early Crawford Peaches Harvested July 27, 1926

Lot No.	Color at harvest	Percent of harvest	Pressure test pounds	Quality
1	Deep yellow or orange around the red cheek	2	7-18	Green to good
2	Greenish yellow to light orange along suture lines	15	14-22	Green
3	Greenish yellow to lemon	36	24-29	Green
4	Green with faint show of yellow on exposed side	47	24-32	Green

After 10 days storage at 33°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Very slight deepening of color	5-15	Very good
2	Very slight deeping of color	13-22	Green
3	No change in color	23-29	Green
4	No change in color	23-31	Green

After 19 days storage at 33°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Very slight deepening of color	3-14	Good to very good
2	Very slight change to deeper color	12-20	Fair to green
3	No change in color, slight wilting	23-29	Green
4	No change in color, distinct wilting	22-30	Green

After 10 days storage at 50°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Cadmium yellow, good condition for use	5—12	Good to excellent
2	Light orange to deep orange. Faint green color showing. Firm for eating	8—16	Poor to fair
3	Greenish yellow to lemon. Too firm for use	12—20	Very poor
4	Greenish yellow. Firm, too green for use	20—27	Green, very poor

After 19 days storage at 50°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Light to deep orange, soft to firm, good condition for eating fresh	3—8	Good
2	Light to deep orange. Green disappeared. Soft, too firm for use as dessert	5—11	Fair
3	Light greenish yellow to lemon. Firm to soft	12—17	Very poor
4	Light greenish yellow to light lemon yellow. Firm, wilted	17—25	Poor-bad

After 10 days storage at 60°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Deep yellow to light. Soft	0—5	Good
2	Yellow to light orange. Soft, firm. Suitable for use	4—9	Fair-good
3	Lemon to light orange. Soft to firm	4—8	Very poor
4	Light greenish yellow to light lemon yellow, soft to firm	3—7	Poor-bad

After 19 days storage at 60°F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Deep yellow to light orange, very soft	0—3	Poor
2	Yellow to light orange, very soft	0—6	Poor
3	Lemon to light orange, soft	0—6	Very poor
4	Light lemon yellow, soft. Not fit for use	0—6	Very poor

After 19 days storage at 33° F. the change in color in Lots 1 and 2 was readily apparent. All fruit of Lot 1 was soft enough for eating, and when the temperature raised to 70° F. gave off the aroma characteristic of the variety. Lot 2 was at its best at this time, and like Lots 3 and 4 later turned brown around the pit but did not ripen.

After 10 days storage at 50° F., Lot 1 was at its best. Lot 2 was still sour but softening. Its best quality was never better than fair and was highest about 12 days after harvest. Lot 3 did not assume the appearance of normally ripe fruit.

After 19 days storage at 50° F., Lot 1 was soft, had lost its highest quality, and was dead ripe. The color was still bright and attractive. The appearance was better than the quality. Lot 2 could not be distinguished from Lot 1 in color and appearance, but was lower in flavor. Lots 3 and 4 were light lemon yellow in color, firm enough for retail trade, but very poor in flavor.

After 10 days storage at 60° F. the fruit of Lot 1 was soft and about one-half of the lot was past a condition fit for use, but those fruits that were usable were of very fine flavor. All of Lot 2 was satisfactory for use but was too soft for handling in retail trade. Lots 3 and 4 were in appearance suitable for market but not in taste.

The data presented in Table 1 indicated the following: First, the fruit softened most rapidly when stored at 60° F. and more slowly as the storage temperature was reduced. Second, the 50° and 60° F. did not sufficiently retard the ripening of the fruit to justify the use of such storage for even a 10-day period. Third, the most immature grades of fruit when stored at 33° F. did not change color nor appear to progress in ripening but wilted instead.

The quality developed by the fruit in the different lots was as follows: Lot 1, the most mature, was good to excellent. Lot 2, next in maturity, was fine to good. Lot 3, less mature than either Lots 1 or 2, was very poor to poor in quality. Lot 4, the least mature harvested, was sour and bitter and unfit for food. The quality developed by each lot was not perceptibly changed by storage temperature.

Tests of Elberta

The Elberta is a large roundish-oblong peach that ripens in midseason. The deep yellow color shades to orange around the edge of the deep red cheek. The flesh is firm, deep yellow, and of good quality. It withstands nicely the handling and storage incidental to shipping and marketing. This characteristic has made it the most popular commercial peach grown in the United States.

Tests of Elberta in 1926. The fruit of Table 2 was grown near Kennewick on well pruned trees of good vigor that carried a medium crop. The ground had been kept fertile by the use of legume cover crops.

The irrigation had been regular and there was no evidence of the trees having suffered from either the lack or excess of water.

The peaches were picked from the trees in the morning, and placed in cold storage before four o'clock in the afternoon. The handling was the same as that in commercial work. The crop was well colored and of good size and form. The flesh was firm and developed high flavor and storage quality.

Elberta peaches harvested from two orchards in the Yakima Valley and from one in the Snake River Valley the same season were described by similar terms. They were stored and tested in a similar manner and the data obtained are essentially similar to those presented in Table 2.

After 16 days storage at 32° F., the most mature peaches (Lot 1) showed some advance in ripening. They were less sour and of good flavor, but were too hard for use as fresh fruit. Lot 2 was changed less

Table 2. Quality and Storage Capacity of Elberta Peaches Harvested August 11, 1926, Kennewick, Washington

Lot No.	Color at harvest	Percent of harvest	Pressure test pounds	Quality
1	Ground color, deep yellow to light orange around crimson check	8	10—18	Good to green
2	Ground color, light yellow to deep yellow on darkest side	60	16—24	Green
3	Ground color, green to light yellow on exposed side	30	22—30	Green
4	Ground color, green to greenish yellow on exposed side	2	22—30	Green

After 16 days storage at 32° to 35° F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Color bright, clean, fresh, good condition. Not ripe enough for good use	8—15	Good
2	Color bright, fresh as at harvest. Firm to hard	14—22	Poor-green
3	Color bright, only very slight fading of green	18—28	Green
4	Color bright, only very slight fading of green, slight wilting	18—28	Green

After 37 days storage at 32° to 35° F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Color slightly faded or dull. Soft but not like ripe	0—5	Not good
2	Color slightly faded or dull. Soft to firm. Not ripe.	0—15	Not good
3	Color slightly faded or dull. Firm to hard, not ripe	5—22	Green-sour
4	Color slightly faded or dull. Firm to hard, not ripe	5—20	Green-sour

After 53 days storage at 32° to 35° F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Color more faded, soft, but not wilting. Brown around pit	0	Very low
2	Color more faded, soft, but not wilting. Brown around pit	0—3	Very low
3	Color badly faded, firm, wilted, brown around pit and brown mottling showing on surface, sour and bitter	0—10	Very low
4	Color and condition not distinct from Lot 3	0—11	Very low

After 14 days storage at 60° F.

Lot No.	Color and condition	Pressure test pounds	Quality
2	Color good, bright yellow. Soft	0—6	Fair-good
3	Color dark creamy yellow. Soft	0—6	Poor
4	Color light creamy yellow. Soft	0—8	Very poor

than Lot 1, and was green and not ready for use. The more immature fruits (Lots 3 and 4) were not noticeably changed from their condition at the time of harvest.

After 37 days storage the color was slightly faded in all lots. Lot 1 was soft but not as sweet as it was after 16 days storage. Lot 2 varied from soft to hard and the color had faded. Both Lots 1 and 2 had

lost most of the aroma characteristic of the tree-ripened fruit and were poor in taste. Lots 3 and 4 were green, sour, and inedible.

After 53 days storage the color of all lots was badly faded assuming a whitish or creamy yellow tint. Lots 1 and 2 were browned around the pit and as far as one-fourth of an inch into the flesh from the pit. The fruit did not taste like ripe peaches. Lots 3 and 4 were wilted, showed a brown mottling on the surface, and were brown around the pit. The hardest material was only firm and when removed from storage decayed very rapidly.

After 14 days storage at 60° F. Lot 1 was badly decayed and no fruits were edible. Lot 2 showed a good bright yellow color shading to orange. The pressure test of all the material was low, but the quality was fair. The fruit could not be shipped or handled commercially. Lots 3 and 4 showed a creamy yellow color instead of the bright yellow color characteristic of the variety. The fruits were soft and of very poor quality.

Tests of Elberta in 1927. The fruit of Table 3 was gathered near Parker from a tree about 12 years old of high vigor and with luxuriant foliage. The tree was well open to the light, but about one-third of the fruit was shaded. The ground was covered with a good alfalfa cover crop and was well irrigated. The fruit was of good size and shape, but light in color. Many fruits ripened on the tree without developing a good yellow color. The crop of that year was below normal in color development and by growers was generally rated as soft and below average in quality.

After 17 days storage at 40° F. all lots were too soft for market handling or canning. The material of Lot 1 had a good flavor, but had the highest aroma when the temperature was raised to 70° F.

This fruit when held at 50° F. for 17 days was past market condition and softer than that held at 40° F. In softening the fruit did not change to the attractive yellow color common to the variety. The peaches in Lots 3 and 4 were mostly a cream color. The flesh of all lots was soft and not equal in texture to the best of the variety.

Fruit harvested from the same orchard September 9 was of essentially the same storage capacity and quality as that harvested September 2. The color standards used in classifying the fruit in 1926 seemed poorly adapted to the crop of 1927 which at no stage of maturity developed color, flavor, and storage quality equal to the former crop.

Fruit was harvested from two other young Elberta orchards in the central part of the Yakima Valley. The trees were growing rapidly when the fruit was harvested. The peaches were sorted and stored in a manner

Table 3. Quality and Storage Capacity of Elberta Peaches Harvested September 2, 1927, Parker, Washington

Lot No.	Color at harvest	Percent of harvest	Pressure test pounds	Quality
1	Ground color, creamy yellow to a light orange around crimson cheek	20	7—16	Good
2	Ground color, greenish yellow to yellow on exposed side	25	9—18	Green
3	Ground color, green to straw yellow on exposed side	45	15—24	Green
4	Ground color, green to yellowish green on exposed side	10	15—25	Green

After 17 days storage at 40° F.

Lot No.	Color and condition	Pressure test pounds	Quality
1	Soft, past market handling. Free from bruises	0—3	Good-fair
2	Soft, light orange, past market condition. Free from bruises	0—5	Medium-fair
3	Soft, ground color very light orange to cream. Past market condition. Free from bruises	0—4	Poor
4	Soft, wilted, greenish white to light cream. Past market condition. Free from bruises	0—3	Unfit for use

similar to those in Table 3. The description of the fruit and the data obtained were similar to those in Table 3, except in some unimportant minor details.

Tests of Elberta in 1928. In late August of 1928, Elberta peaches were harvested near Kennewick from trees about 14 years old, in good vigor, and with well opened tops to expose the fruit to light. The land had been kept fertile by cover crops and fertilizer applications and was well irrigated. The trees carried a medium to heavy load of fruit.

The fruit was of high quality, well colored, of good shape, and developed high flavor and keeping qualities. The lots were described by the terms used in Table 2. The pressure tests at harvest were: Lot 1, 7 to 16 pounds; Lot 2, 12 to 22 pounds; Lot 3, 16 to 28 pounds, and

Lot 4, 18 to 28 pounds. The peaches were harvested in the morning and packed and placed in a 32° F. storage room before evening. After three days they were moved to a 40° to 45° F. storage room.

After seven days storage at 40° F., the most mature peaches (Lot 1) were in prime condition for use as fresh fruit. They were nearly free from bruises, and the yellow color had deepened throughout the flesh. The peaches were satisfactory for any fruit stand and were of excellent flavor. The pressure test had dropped to 3 to 8 pounds. Lot 2 had changed to a distinctly deeper yellow color and was in prime condition for handling. The pressure test was 7 to 17 pounds. When brought to room temperatures ranging from 70° to 75° F. within 24 hours the fruit was in prime eating condition. The aromas of Lots 1 and 2 were comparable. The fruit of Lots 3 and 4 was hard and too firm and green for use. The pressure test was 13 to 23 pounds. When exposed to temperatures of 70° to 75° F., the peaches softened in three days to about the stage ordinarily used for fresh fruit. They were then of very poor quality, very sour, and lacking in the aromatic taste of the variety.

After three days storage at 32° F. and 23 days storage at 40° F. all the fruit had softened. The maximum pressure tests were: Lot 1, 3 pounds; Lot 2, 5 pounds; Lots 3 and 4, 8 pounds. Much of the more maturely harvested fruit (Lots 1 and 2) was excellent for eating out of hand, but was too soft for canning purposes. The flavor was much lower than when examined 10 days after harvest. The more immaturity harvested material (Lots 3 and 4) was very poor and unattractive in quality. The green color had changed to a light yellow and not to the attractive deep yellow or orange of the well matured lots.

Tests of Elberta in 1929. Elberta peaches were harvested September 4, 1929 near Grandview from trees about 16 years old that were making medium growth. The land, a deep fertile loam, was well irrigated and the trees showed no signs of water shortage or other condition unfavorable to growth. The fruit was lighter in color than that described in Table 2, but not as light in color as that in Table 3. It was of good size and shape, but was only medium in quality for the variety. The pressure tests at harvest were: Lot 1, 7 to 12 pounds; Lot 2, 11 to 19 pounds; Lot 3, 14 to 25 pounds; and Lot 4, 16 to 28 pounds. The fruit was packed, and placed in cold storage at 32° F. within four hours after picking. After 24 hours in cold storage, the peaches were shipped by express to Pullman and placed in a storage room of 40° F.

After one days storage at 32° F. and after seven days storage at 40° F., Lot 1 (the most mature fruit) was in prime condition for use. This fruit softened more rapidly during the first few days of storage than any of the other lots. Between the period of 9 and 12 days of storage, the fruit in Lot 4 softened most rapidly.

After 12 days storage at 40° F. the fruit showed no noticeable change in color. Lot 1 gave a pressure test of 0 to 3 pounds, and was medium to good in quality. Lot 2 was soft to firm, and gave a pressure test of 0 to 5 pounds and was medium only in quality. Lots 3 and 4 gave a pressure test of 0 to 5 pounds and were poor to very poor in quality.

Other Elberta peaches were harvested near Yakima September 9, 1929, and placed in a 40° F. storage room within 18 hours after picking. The fruit was from trees about 12 and 13 years old, medium in size and well colored, about the same as that in Table 2. The pressure tests were: Lot 1, 7 to 12 pounds; Lot 2, 12 to 19 pounds; Lot 3, 14 to 26 pounds; and Lot 4, 18 to 30 pounds. After 12 days storage at 40° F., the average pressure test of Lot 1 was 3 pounds; of Lot 2, 5 pounds; of Lot 3, 5 to 8 pounds; and of Lot 4, 5 to 7 pounds. The quality of Lot 1 was good to excellent; Lot 2, good; and Lots 3 and 4 very poor and not suitable for use.

The fruit that year from the different orchards varied greatly in color. The high color and tree maturity were uniformly co-existent with high quality.

Tests of Elberta in 1930. The fruit was produced near Yakima by trees about 10 years old in medium vigor and carrying a medium to heavy crop. The trees had been well pruned and the tops opened so as to expose the fruit to the sun. The soil had been kept fertile by the use of cover crops, and was well covered with a good growth of alfalfa when the fruit was harvested. The land had been well irrigated, and the trees and crop were in excellent condition. The fruit was of good size, well formed, and highly colored. The flesh was firm and of high quality in texture and taste. The fruit used was gathered and packed before noon September 1, 1930. It was held in 70° F. storage for 24 hours, to represent a common commercial method of handling, and then stored at 40° F.

The different lots were well described by the color descriptions in Table 2. The pressure tests at harvest were: Lot 1, 8 to 13 pounds; Lots 2, 12 to 17 pounds; and Lot 3, 17 to 23 pounds. The quality of Lot 1 was good to excellent, and of Lots 2 and 3, green.

After 24 hours storage at 70° F. and 3 days at 40° F., the green color had partly disappeared, leaving the yellow more prominent. Lot 3, however, developed only a pale yellow color during the entire test. The pressure tests and quality were: Lot 1, 2 to 7 pounds, very good; Lot 2, 4 to 10 pounds, good; and Lot 3, 5 to 15 pounds, green and very sour and bitter. The flesh changed color about as did the skin, but the texture was that of green fruit. The one day's storage at 70° F. seemed to carry the process of ripening so far that it was retarded but little by the lower temperature.

After one day's storage at 70° F. and 21 days at 40° F., Lot 1 was decayed; Lot 2 was soft, gave a pressure test of 2 to 5 pounds, and was past its best quality but still edible; Lot 3 was soft, with a pressure test of 2 to 5 pounds, of light yellow color, and very poor to bad in quality. The rate of softening seemed to be most rapid immediately following harvest and to become gradually slower in the latter part of the test.

Softening of Elberta Peaches. The relative rates of softening, of fruit of different degrees of maturity designated as Lots 1, 2, 3, and 4, are illustrated in Figures 1 and 2. The peaches, from which the data presented in Figure 1 were developed, were harvested in 1928 and stored at a temperature of 50° F. The fruits were typical, medium sized Elberta peaches of good color and quality. As indicated the fruit softened slowly during the first four-day period following harvest and then more rapidly for eight days. The most mature fruit (Lot 1) softened less rapidly than the more immature (Lot 4).

Figure 2 presents data obtained from fruit harvested in 1927, which was typical in appearance and storage activity of much of the fruit of that season. The fruit did not develop the deep yellow and red colors that are typical of the variety at its best. The green, yellow, and red colors of the fruit were lighter and the quality lower than that of the material represented in Figure 1. Figure 2 shows the same general curves presented in Figure 1, but the fruit was softer at harvest and in color seemed to be less mature.

Tests of J. H. Hale

The J. H. Hale is a large round peach that ripens in mid-season. The skin is deep yellow, shading through orange to a deep red color on the side most exposed to the sun. The flesh is firm, deep yellow in color, and of good quality. It is generally considered to be of better quality than the Elberta and as good or better as a shipping and marketing peach.

Tests of J. H. Hale in 1927. J. H. Hale peaches were harvested from one orchard on September 2, 1927, from trees about 12 years old of high vigor and luxuriant foliage. The tops of the trees were well opened to the light and carried a full crop, but the heavy foliage shaded about one-third of the fruit. The ground was well irrigated, and was covered with a good alfalfa cover crop.

The fruit was of good size and shape but light yellow in color. Many individual fruits ripened on the tree without developing a good yellow color. The entire crop of the orchard that year was low in the color developed, and was said by the owner to be softer and lower in quality than former crops. The color development of the lots of different maturity is well described in Table 3. The pressure tests and quality at

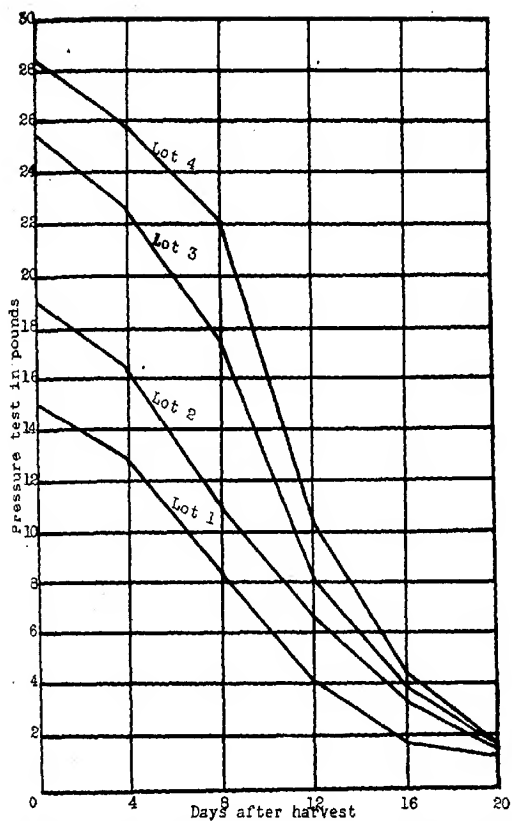


Figure 1. Softening of Elberta peaches of the best color and quality stored at 45 degrees F. Pressure tests were made 4, 8, 12, 16, and 20 days after harvest.

harvest were: Lot 1, 4 to 5 pounds, medium to good; Lot 2, 6 to 16 pounds, green; Lot 3, 12 to 24 pounds, entirely green; Lot 4, 15 to 28 pounds, entirely green.

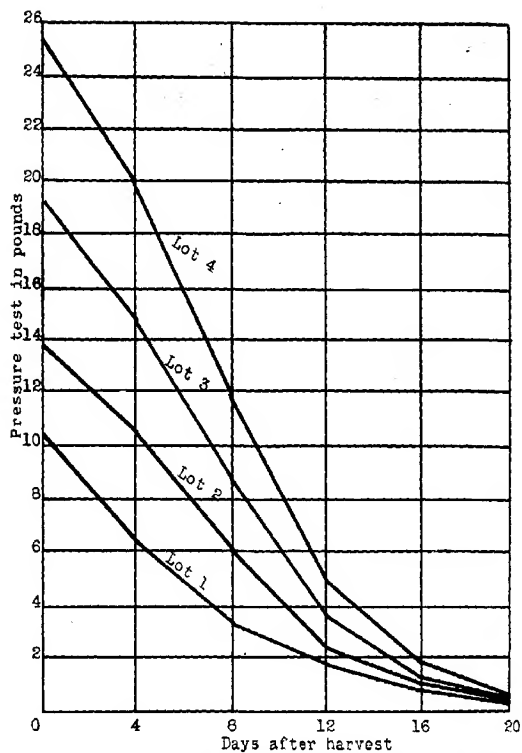


Figure 2. Softening of Elberta peaches of poor color and quality stored at 45 degrees F. Pressure tests were made 4, 8, 12, 16 and 20 days after harvest.

The material was harvested in the forenoon and stored at 40° F. within eight hours after picking. The fruit softened so rapidly, that after 17 days of storage it was unfit for market. The pressure tests and quality were: Lot 1, 0, good; Lot 2, 0 to 7 pounds, poor to medium; Lot 3, 0 to 6 pounds, very poor; Lot 4, 0 to 4 pounds, bad, unfit for food.

Fruit of the September 9 harvest was stored at 50° and at 60° F. This fruit ripened more rapidly than that stored at 40° F., but did not rapidly decay. Some fruit was kept for 25 days at 60° F. with very little decay, but was too soft for market handling after seven days.

Peaches kept for 25 days at 50° F. showed almost no decay. The taste of the fruit was best after 5 days of storage, and the quality gradually became lower after that date. After 17 days, the best of the material was only fair in taste, and after 25 days it was over-ripe and poor in taste. The color, flavor, and storage quality of the 1927 crop were low.

Tests of J. H. Hale in 1928. Peaches were gathered from an orchard near Buena from trees which were about 12 years old and in a medium state of vigor with broad, open, spreading tops. The land was a deep fertile loam and had been well irrigated. The trees showed no evidence of lack of water, and conditions were favorable for growth and development.

The harvest was carefully supervised and only peaches of medium to large size, well shaped, and with maturity which would place them with Lots 1, 2, or 3, were picked. The fruit was packed and in storage within 24 hours after harvest. It was of medium to large size and well shaped. The colors of the different lots are well described in Table 2. The pressure tests at harvest were: Lot 1, 10 to 18 pounds; Lot 2, 14 to 22 pounds; Lot 3, 18 to 28 pounds.

The peaches when examined after 12 days of storage at 40° F. showed no change of color in Lots 1 and 2. In Lot 3, the color had changed to a light yellow of dull appearance, without any green. The pressure tests and quality were: Lot 1, 0 to 8 pounds, very good; Lot 2, 6 to 12 pounds, good. The pressure test of Lot 3 was 7 to 14 pounds, which was too firm for best use and resulted in poor quality. The texture of the flesh was not like that of the fruit in Lots 1 and 2, but more fibrous. After 24 days storage, all lots were too soft for use. Lot 2 retained a bright clean appearance, but it had lost quality in taste. After 12 days' storage at 50° F. the fruit showed more rapid ripening and breakdown than that held at 40° F. The pressure tests and quality were: Lot 1, 0 to 5 pounds, good; Lot 2, 3 to 9 pounds, medium to good; Lot 3, 4 to 11 pounds, poor. The quality of each lot in 50° F. storage was lower, but the fruits of comparable firmness to those in 40° F. storage were of equal or slightly superior quality. Fruits of Lots 1 and 2 tasted at intervals of 5 to 10 days' storage seemed to have higher aroma and more pleasing flavor than those held at 40° F.

The storage temperature of 40° F. retarded the softening of Lot 3, the somewhat immaturity harvested fruit, more than Lot 2, and retarded softening of Lot 2 more than Lot 1. In the storage temperature of 50° F.

the softening or ripening of Lots 2 and 3 was more rapid than of Lot 1, although not as quickly finished.

J. H. Hale peaches harvested at Kennewick September 2 were sorted and stored at 40° and 50° F. In appearance and storage response, they were similar to the material harvested at Buena. The fruit was from an orchard in good vigor, and ranged from medium to large in size.

Tests of J. H. Hale in 1929. The fruit was harvested near Naches from trees about 10 years old in good growth and vigor, bearing a full crop. The land sloped to the south and was covered by a thin stand of alfalfa. The soil had been well irrigated during the season but not for 14 days prior to the date of harvest.

The fruit was harvested before noon and in storage of 40° F. before night. Most of the material was of the second picking from the trees and represented the average of the crop. The descriptions of the color of the fruit were similar to those in Table 2. The pressure tests and quality at harvest were: Lot 1, 10 to 18 pounds, green to good; Lot 2, 15 to 25 pounds, green; and Lot 3, 18 to 28 pounds, green.

After 10 days' storage at 40° F., the color and appearance of Lots 1 and 2 were unchanged. Lot 3 had changed from a yellowish green to a light yellow. The pressure tests and quality were: Lot 1, 3 to 9 pounds, very good; Lot 2, 7 to 13 pounds, good; and Lot 3, 7 to 14 pounds, poor.

After 22 days storage at 40° F. all the fruit was too soft for marketing and was low in aroma and taste. The most immature fruit (Lot 3) at harvest was as soft as the other and bitter in taste.

J. H. Hale peaches were harvested September 6, 1929 near Grandview and stored in a similar way as the fruit from Naches. The fruit was from vigorous trees about eight years old. The soil had been heavily irrigated throughout the season. The fruit had increased rapidly in size during the seven days preceding harvest.

At harvest, Lot 1 showed a pressure test of 5 to 9 pounds, Lot 2, a test of 9 to 15 pounds, and Lot 3, a test of 13 to 25 pounds. The color in the most immature varied from a grayish green to a light yellow and in the most mature from a pale yellow, to a light orange on the exposed cheek, overlaid with pale carmine.

After 10 days storage, the most mature fruit (Lot 1) showed no change of color, but was too soft for handling. The appearance of the fruit was medium to good, but the taste was insipid and the aroma was nearly lacking. The flesh was coarse grained and less juicy than common. Lots 2 and 3 were lighter in color than when stored. The flesh was soft and had only a fair or medium taste. Lot 4 had changed from a pale amber to a light lemon-yellow color. The taste was very sour and bitter. After 15 days' storage all material tested below three

pounds, which is too soft for commercial handling. The color had not changed from that previously existing, after 10 days' storage.

Tests of J. H. Hale in 1930. Fruit was harvested near Yakima from trees about eight years old in good vigor. The tops of the trees were open and well exposed to light and carried a medium size crop. The fruit was well-developed, of good shape and color, and of high quality. It was picked and packed before noon September 3, stored at 70° F. for one day, and then placed in 40° F. storage. The temperature of the fruit in the center of the boxes was 55° F. at the end of the first day in the 40° F. storage, and remained at from 43° to 45° F. thereafter. The color of the different lots of peaches was a little deeper yellow and orange than that of the lots of Table 2. The fruits were all large to very large and of better than average flavor. The pressure tests and quality at harvest were: Lot 1, 5 to 13 pounds, very good; Lot 2, 14 to 22 pounds, green, and Lot 3, 16 to 28 pounds, green.

After 24 hours storage at 70° F. and five days at 43° F. there was no change in color and appearance of the fruit of Lots 1 and 2, but the fruit of Lot 3 changed to a creamy yellow with a more distinct show of carmine on the exposed side. The pressure tests and quality were: Lot 1, 0 to 5 pounds, very good; Lot 2, 9 to 16 pounds, medium to good; Lot 3, 14 to 22 pounds, green.

After 24 hours storage at 70° F. and 19 days at 43° F., the color of all lots of fruit had faded, was less attractive, and Lot 3 had slightly wilted. The pressure tests and quality were: Lot 1, very soft, not edible; Lot 2, 2 to 7 pounds, medium quality; and Lot 3, 5 to 13 pounds, very sour and slightly bitter taste with fibrous texture.

Softening of J. H. Hale. Figures 3 and 4 show the rate of softening of fruit of the J. H. Hale variety with maturity representative of Lots 1, 2, and 3, in storage temperature of 45° F. The data presented in Figure 3 were obtained in 1928 from midseason harvested fruit of medium size, of good form, color, and quality. The figure shows that there was a gradual increase in rate of softening until near the end of its storage life. The most mature fruit (Lot 1) softened less rapidly than did the immature lots, but was too soft for commercial handling. The most immature fruit (Lot 3) was last to change from firm to soft. The Lot 1 fruit remained firm and of good quality for about 12 days.

The data obtained from J. H. Hale peaches of low color and quality are presented in Figure 4. This fruit was softer when harvested, although less highly colored than that in Figure 3, and softened more rapidly in storage.

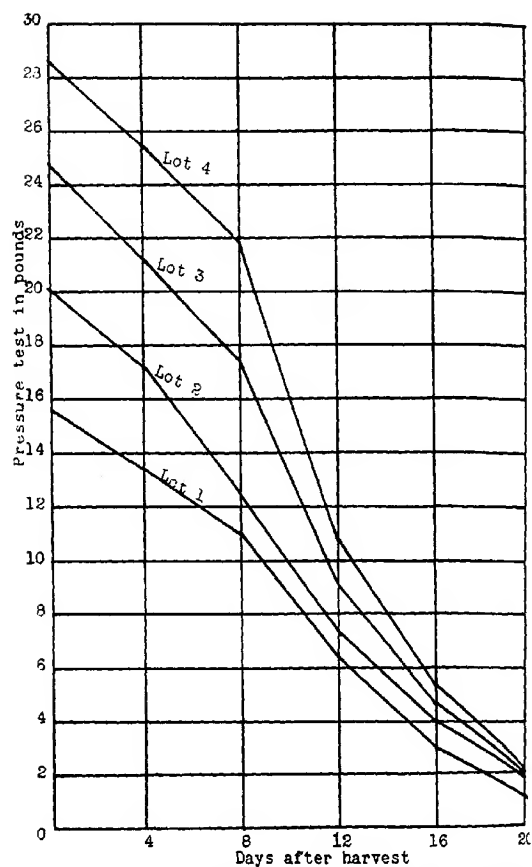


Figure 3. Softening of J. H. Hale peaches of good color and quality stored at 45 degrees F. Pressure tests were made 4, 8, 12, 16 and 20 days after harvest.

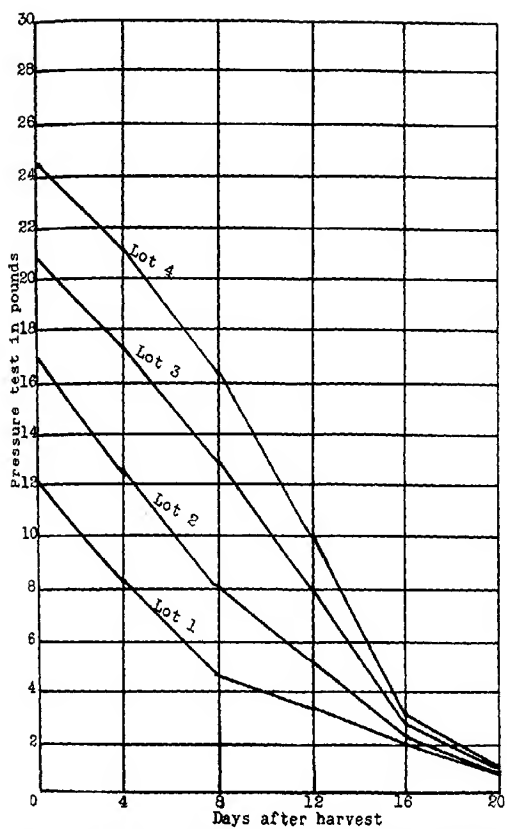


Figure 4. Softening of J. H. Hale peaches of poor color and quality stored at 45 degrees F. Pressure tests made 4, 8, 12, 16 and 20 days after harvest.

Minor Varieties

The Early Elberta is, as the name indicates, an early peach similar to the Elberta. It is not equal to the Elberta in shipping quality. Fruit of this variety was harvested, sorted, and used in one storage test. The experiments indicated that this variety can be sorted on the same basis as the Elberta. Fruit having the maturity of Lot 2 was sufficiently mature to develop into fair quality and withstand shipments to which the fruit may be normally subjected.

Gold Medal is a midseason peach of the Elberta type of slightly better quality. One test with it indicated that it could be sorted and handled on the same grading basis as the Elberta and that it seemed to have as good shipping qualities as the Elberta.

Rochester is an early yellow peach somewhat similar to the Early Crawford, but is of better market quality. The trials with it indicated that it can be sorted and handled on the same grading basis as the Early Crawford. It seems to respond to storage about the same as that variety.

Late Crawford is a large late yellow peach of excellent quality. The flesh is tender and does not withstand shipping well. For market shipments, Lots 1 and 2 were handled satisfactorily, but the trials made with it did not indicate that it was suitable for long distance shipments or storage for more than seven or eight days under the most favorable circumstances.

Carman, Hale Early, and Mountain Rose, are early ripening, white or cream-colored peaches with a red cheek. These were used only in preliminary trials of storage, and were found soft and of limited storage quality. The flesh is tender, easily bruised, and of high quality if approximately tree ripened but of distinctly low quality when picked green.

Storage Temperatures

A storage temperature of 32° to 33° F. has very commonly been assumed to be best for all fruits. Overholser, Winkler, and Jacob (10) reported better results in reducing losses from internal browning with storing Yellow Newtown apples at 40° and 50° F. than at lower temperatures. Hartman, Reimer, and Norris (11) reported that best results in quality of pears are obtained when the fruit is ripened at temperatures of 60° to 70° F., and that a very poor product is developed by ripening this fruit in 32° F. storage. The peach crop is commonly rushed to market as rapidly as possible. The temperatures commonly prevailing during peach harvest favor rapid ripening and decay of the fruit. The fruit of best eating quality and flavor, therefore, unfortunately is thrown in the cull box as "over-ripe."

Fruit of Elberta and J. H. Hale varieties was held at storage temperatures of 32°, 40°, 50°, and 60° F., and studies were made of the

response of each variety to these temperatures. The fruit was sorted into lots of different degrees of maturity. Lot 1 was the most mature and Lot 3 the least mature. The color descriptions were similar to those in Table 4 for Elberta and Table 8 for J. H. Hale. The data obtained for the two varieties were so nearly the same that only the figures representing the softening of Elberta are given. The J. H. Hale was a little firmer fruit and a little better colored.

Elberta Response to Storage Temperatures. Figure 5 shows the storage response of the Elberta peaches of Lot 1 gathered in midharvest of 1928 and immediately stored at 32°, 40°, 50°, and 60° F. The fruit was of good quality, texture, and color. The sizes varied from 55 to 65 fruits per box. Peaches which were stored at the temperature of 32° F. softened very slowly, and kept for 14 days without appreciable change in appearance. In 21 days they had noticeably softened, were low in aroma, but were still in good eating condition. The quality was fair to good.

Fruit stored at 40° F. ripened more rapidly and developed a higher aroma 10 days after harvest than that held at 32° F. had at any time after harvest. This fruit was of good quality and flavor 20 days after harvest, and although for the last three days it was distinctly soft, was still edible.

Lot 1 held at 50° F. developed high quality, which was retained for about 10 days after harvest. The quality then deteriorated gradually until about 17 days after harvest when the fruit was too soft to be attractive.

Lot 1 stored at 60° F. developed the highest quality, was soft enough for dessert purposes in two days after harvest, retained high quality until about the seventh day, and after that time deteriorated very rapidly. After 10 days it was too soft to be attractive and had lost the distinct aroma of the lot.

The fruit from which the data for Lot 2, presented in Figure 6, were obtained was picked in the midharvest of 1928 and immediately stored at 32°, 40°, 50°, and 60° F. The fruit was of good grade, well colored, and of good texture; sizes ranged from 55 to 65 fruits per box.

Lot 2 stored at 32° F. softened very slowly. At the end of 20 days the material was still hard and had changed but little in color. The yellow had faded slightly and the green had changed to a grayish green. The fruit was poor to fair in flavor and was too green to be attractive.

Lot 2 held at 40° F. ripened very slowly for the first eight days. After that interval the ripening progressed more rapidly, and the fruit was in good edible condition on the twelfth day, retaining good but not excellent quality until the nineteenth day after harvest. At that time and later it could be classed as no better than "poor to fair." The peaches had lost nearly all of the green shade of color and most of the aroma.

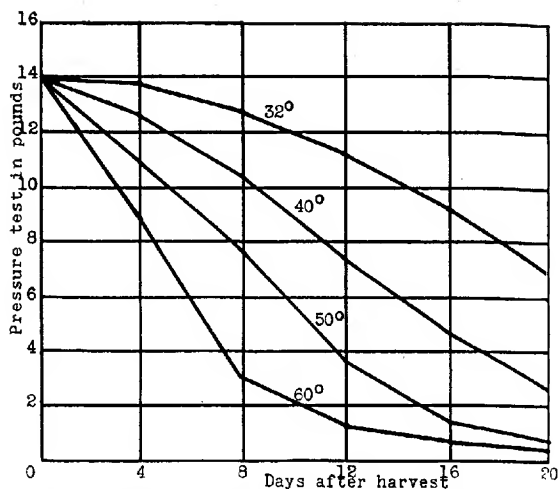


Figure 5. Softening of Elberta peaches of Lot 1, stored at 32, 40, 50 and 60 degrees F. Pressure tests were made 4, 8, 12, 16 and 20 days after harvest.

Lot 2 stored at 50° F. was in good edible condition after seven days' storage, and retained that quality until the fourteenth day. At an examination on the sixteenth day, the material was found to be noticeably deteriorating and on the twentieth day was unusable. The aroma of the fruit was good until about the twelfth day of storage, no noticeable change having taken place up until that date, but from then on it deteriorated rapidly.

Lot 2 stored at 60° F. varied greatly. Some of the fruit was soft enough for out-of-hand eating at four days after harvest. Most of it, however, was not in good condition for this use until about the seventh day. The fruit developed good quality and a high aroma which was maintained until the eleventh day of storage. From that time on it deteriorated rapidly, and passed beyond usable condition after two weeks of storage.

The Elberta peaches from which the data for Lot 3, presented in Figure 7, were obtained, were picked in midharvest of 1928, and immediately stored at 32°, 40°, 50°, and 60° F. The fruit was well colored for its state of maturity and of good texture and size, packing 65 fruits per box.

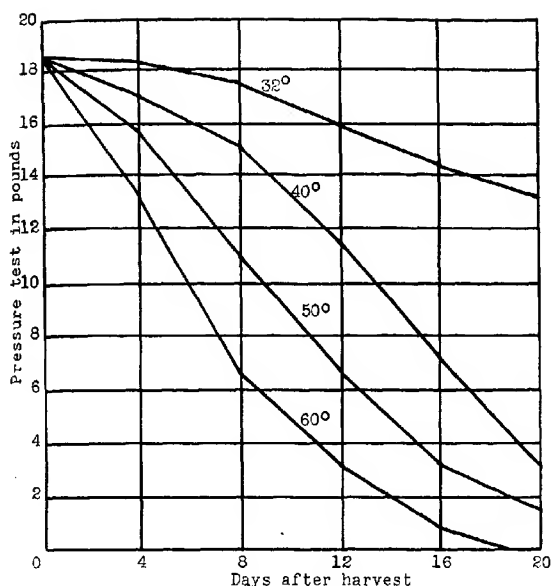


Figure 6 . Softening of Elberta peaches of Lot 2, stored at 32, 40, 50 and 60 degrees F. Pressure tests were made 4, 8, 12, 16, and 20 days after harvest.

The peaches stored at 32° F. softened very slowly for the first 12 days, but after that the softening process was more rapid. At no time did the fruit at this temperature develop a pleasing aroma nor an attractive yellow color, or change from a green to a yellowish green. In texture, the material was that of green fruit 30 days after harvest, and the flesh had turned brown around the pit.

Lot 3 when stored at 40° F. softened very slowly the first eight days of storage, then seemed to soften rapidly for about 25 days. At this temperature the fruit changed slowly to a light yellow, between a cream and butter color. After 16 days of storage the fruit was soft enough for use as dessert fruit, but was unpleasant in taste and aroma.

Lot 3 stored at 50° F. softened slowly until eight days after storage, then very rapidly during the next eight days. The fruit was sufficiently

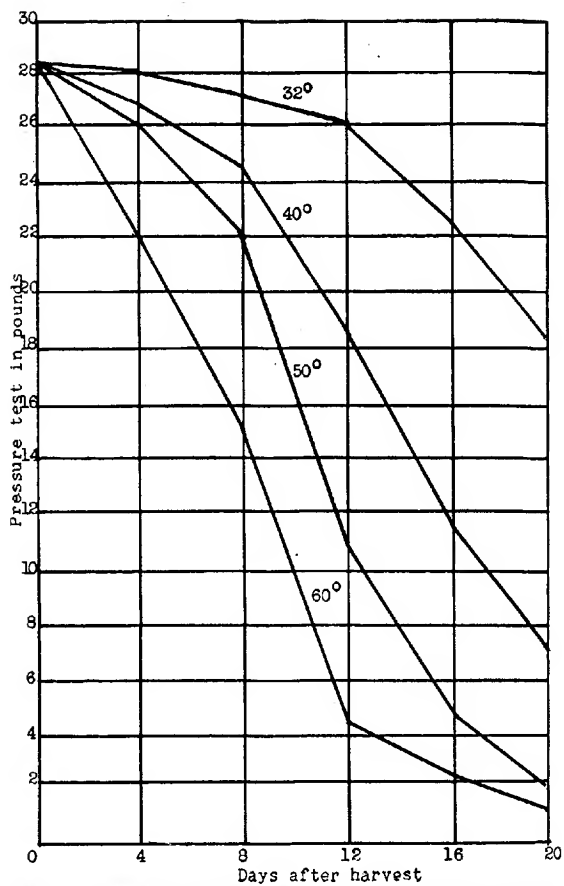


Figure 7. Softening of Elberta peaches of Lot 3, stored at 32, 40, 50 and 60 degrees F. Pressure tests were made 4, 8, 12, 16 and 20 days after harvest.

soft for dessert use at 12 days after storage but was unattractive. At this temperature, however, the lot attained its maximum quality.

Lot 3 stored at 60° F. softened rapidly from the date of harvest. At no time was it of high quality. During the period from four to eight days after harvest it developed a slight aroma, which at no time approached the fragrance common to Lots 1 and 2. When softened to a six-pound pressure test, the fruit was sour and had a peculiar flat, insipid, bitter taste.

Influence of Change of Storage Temperature

Fruits of Early Crawford, Elberta, and J. H. Hale varieties having the maturity of Lots 1 and 2 were stored at 32° F. for eight days and then moved to 50° and 60° F. All the fruit ripened and became good in flavor and quality. Although the fruit seemed to have changed but little in appearance and hardness during the eight days storage at 32° F. it ripened a little more rapidly when moved to 50° and 60° F. than the fruit stored at these temperatures immediately after harvest. The material stored at 32° F. for eight days and then ripened at 50° and 60° F. seemed to have nearly as good quality as that ripened at the higher temperatures immediately after harvest. Fruit stored at 32° F. for 15 days and then brought into temperatures of 50° to 60° F. did not ripen and develop as high quality as the fruit brought into the higher temperatures at a period of 8 or 10 days after harvest.

Changes in Flavor

The change in flavor of these different lots as they ripened in storage was not as distinct as the change in texture. The flavor of the fruit in Lot 1 was uniformly sweeter and had more aroma than that of the other lots. The aroma was slightly increased as the fruit softened in all lots, but in Lots 3 and 4 it never attained the fragrance common in Lots 1 and 2. Lot 1, in storage at 50° F. or above, assumed the highest flavor and was usually sweet and very aromatic. Lot 2 was less sweet and less aromatic but still pleasing in taste. Lot 3 in the highest colored specimens attained a flavor that was hardly sweet, and in the poorer colored specimens the flavor was sour and often bitter. Lot 4 attained a flavor that was best characterized as insipid, or sour and bitter.

Variability of Fruit Color

From the data it is seen that there are slight variations in the descriptions of the color of the different lots. A careful comparison with a few standard colors developed the fact that the color of peaches at any given stage of maturity varied each year. There were also slight differences in the color development of fruit from different orchards in the same year. The color of the fruit of the first picking was usually deeper and more distinct than that of later harvests. The color attained

for proper harvest maturity varied primarily with the variety. Within a variety, color was found to vary from orchard to orchard and from season to season and in some cases even during the season in one orchard. Nevertheless, color, because of its ease of recognition, was the most satisfactory of any maturity gauge tested.

The color changes that take place in the Elberta and J. H. Hale peaches as they ripen on the tree are very noticeable. In storage, however, the changes that take place as the peaches soften are different and much less apparent. There seemed to be a disappearance of the green color in Lots 2, 3, and 4. This, however, was not by intensification of the yellow color. In highly colored specimens the yellow seemed to increase slightly in intensity as the fruit softened, but in poorly colored specimens this change was not distinct. Instead of changing to a light orange with softening, the flesh assumed a yellowish creamy color lacking in attractiveness.

Changes in Texture

The change in texture of the different lots as they softened in storage was as distinct as the change in color. Fruit classed as Lot 1 retained the most edible type of flesh; Lot 2 was less crisp; Lots 3 and 4 became soft and leathery in texture. They wilted badly unless the humidity of the storage room was kept very high.

Handling Quality

The fruit in Lot 1 bruised most easily of any of the lots. With careful handling, however, fruits of the 45 size and smaller were packed in commercial peach boxes and shipped direct from packing houses to Pullman, and also after a precooling of 24 hours were shipped to Pullman with less than one per cent of the fruit showing soft bruises. In these shipments the fruit was sent by express from Yakima Valley to Spokane, where it was transferred from one train to another, and arrived in Pullman about 24 hours after harvest. Lot 2 fruits went through the same shipment with almost no bruises. Lots 3 and 4 showed no soft bruises from any shipment.

Fruits of approximately the same stage of maturity but of the first and last pickings of the crop of Elberta and J. H. Hale were tested for storage quality and flavor. The first ripe fruits of Elberta from three orchards in 1927 were of better storage quality and flavor than those of the last harvest. The reverse was true in two other orchards. In 1928 the first harvested J. H. Hale peaches were best in three orchards, and the reverse was true in three other orchards. In 1929 the first harvested Elbertas were best in four orchards, and the last harvested were best in quality in two orchards. The first harvested J. H. Hale peaches were best from three orchards, and the last harvested were the best in two orchards. In 1930 the fruit of the first picking was best in two Elberta

orchards and the last picking in one orchard. The first picking in three J. H. Hale orchards was best and the last picking best in two other orchards.

High storage quality and flavor were generally co-existent with a high color of fruit and a medium to strong growth of tree. The harvest of the best quality of fruit was usually preceded by 3 to 10 clear warm days of low humidity. Low storage quality and flavor were usually indicated by low color and were commonly co-existent with one of the following: Extremely large or very small fruit; very rapid or very slow tree growth; and harvest preceded by a few cloudy, relatively humid days.

SUMMARY

1. This report includes the study of peach maturity and keeping quality for five successive seasons, beginning with the summer of 1926. The work has dealt mostly with the state of maturity at time of harvest and the relation of the degree of maturity to the shipping and storage capacity of the fruit and its quality when it reaches the consumer.

2. The maturity of peaches is difficult to measure. There is an overlapping of the processes of growth and ripening. The size of the fruit oftentimes continues to increase after the fruit begins to soften along the suture line and on the base of the cheek next to the stem. The rates of softening and of growth that co-exist vary from year to year and tree to tree, and depend upon the weather and growth conditions prevailing.

3. The form of the fruit cannot be used uniformly as an indication of its maturity. Fruits that are grown under the most favorable conditions increase their lateral diameter during the latter part of the growth period more rapidly than they increase in length. Their tendency is to become broader and oblate as they reach the ripening stage. If grown under less favorable conditions during the latter part of the growth period, this broadening of the fruit oftentimes does not occur, and the fruit softens while it is much longer than wide.

4. The ease of separation of the fruit from the stem cannot be used as a standard by which to determine the degree of maturity. Some fruits that are tree ripened hold tenaciously to the stem, while others that are green and growing rapidly separate very easily. This condition seems to be influenced by the growth conditions prior to the last stage of maturity, as much as by the condition of the fruit at maturity.

5. Pressure tests cannot be used independently of other methods in determining harvest dates or selection of fruit to be picked. They can often be used to determine the color standards for each picking. At any one date from the beginning of the picking season,

peaches of extreme hardness and extreme softness may be found on the same tree attached to the same type of twigs located in the same sections of the top.

6. Color development of the fruit is related to the stage of maturity and ripening. It has not been possible to designate certain fixed color lines as the basis for selection of fruit for satisfactory picking. The type of growth made by the tree, the amount of load, the weather conditions, and probably other factors influence the color development so that it has not been possible to make definite color limitations on picking work.

7. A combination of pressure test and color seems to be the best method of arriving at a standard or gauge to use in harvest work. These will often be changed slightly during the harvest of one crop, but this fact does not prevent such a gauge being valuable. The knowledge of the crop and its development gained by the orchard men in handling it forms a very valuable basis of judgement, which is necessary for the best results in growing and harvesting peaches of high quality for good markets.

8. Adequate maturity of peaches is necessary for the attainment of highest quality. Complete maturity of the fruit before picking will prevent its shipment to distant markets without heavy loss. The fruit that is still hard and green when harvested will endure rough handling in packing and will show less picking and shipment injury than the fruit of more advanced maturity. The green fruit, however, is of very inferior quality when ripened, and is unattractive for use even when soft enough for eating out of hand or for culinary purposes.

9. Thirty-two degree F. storage seems to prevent the normal changes that take place in fruit which are co-existent with ripening. The fruit of all stages of maturity at harvest time that softened in such storage was uniformly of very low quality.

10. Storage temperatures varying from 40° to 50° F. kept the fruit in good condition, retarded the softening processes, but permitted normal ripening of mature fruit so that good quality material was drawn from the storage room from 5 to 15 days after harvest.

11. The fruits of first or earliest harvest of a variety were, in more than half the cases examined, of higher color and higher quality than the fruits of the last picking. A study of the material on the trees indicated that direct exposure to light was more common with fruits high in color and harvested early than with fruits harvested late.

12. The Elberta and J. H. Hale varieties are the main crop commercial peaches of Washington. A few other varieties of minor importance are briefly described as they are only a small part of the commercial crop.

Acknowledgment

The author takes pleasure in expressing his appreciation of the help given in the experimental and investigational work. The White Brothers and Crumb Company donated the fruit obtained from Wawawai. The Yakima Fruit Growers' Association; the Yakima County Horticultural Union; the Lombard-Horsely Company; and Wendell P. Brown, all of Yakima; and Combelic & Perry, Inc., Kennewick, Washington gave valuable assistance in the work. Several fruit growers gave freely of their time and facilities to assist in the work. Doctor J. R. Magness of the United States Department of Agriculture and Doctor E. L. Overholser have given helpful suggestions and criticisms.

Literature Cited

1. Hedrick, U. P., The Peaches of New York. N. Y. Exp. Sta. Ann. Rept. Pt. II, 1916.
2. Kantor, H. S., Factors Affecting the Prices of Peaches in the New York City Market. U. S. D. A. Tech. Bul. 115, April, 1929.
3. Lloyd, J. W. and Newell, H. M., Some Factors Influencing the Keeping Quality of Fruit in Transit. Ill. Agr. Exp. Sta. Bul. 350, Jan. 1930.
4. Morris, O. M., Peach Harvesting. Wash. State Hort. Assn. Ann. Rept. pp. 21, Dec. 1929.
5. Morris, O. M., The Problem of Peach Harvesting. Wash. State Hort. Assn. Ann. Rept. pp. 98-99, Dec. 1927.
6. Duruz, Willis P., Harvesting and Handling California Peaches for Eastern Shipment. Cal. Agr. Exp. Sta. Cir. No. 241, May, 1922.
7. Lloyd, J. W., Directions for Grading and Packing Illinois Peaches. Ill. Exp. Sta. Cir. 343, Jan. 1929.
8. Blake, M. A., Length of Fruit Development Period of the Elberta and Some Other Varieties of Peaches. N. J. Agr. Exp. Sta. Bul. 511, pp. 13, Oct. 1930.
9. Culpepper, Charles W. and Caldwell, Joseph S., The Canning Quality of Certain Commercially Important Eastern Peaches. U. S. D. A. Tech. Bul. No. 196, pp. 18-25, Oct. 1930.
10. Magness, J. R. and Taylor, G. F., An Improved Type of Pressure Tester for the Determination of Fruit Maturity. U. S. Dept. Agr. Cir. 350, 1925.
11. Overholser, E. L., Winkler, A. J., Jacob, H. E., Factors Influencing the Development of Internal Browning of the Yellow Newtown Apple. Cal. Agr. Exp. Sta. Bul. 370, September, 1923.
12. Hartman, Henry, Reimer, F. C. and Norris, R. K., Further Investigations on the Harvesting, Storing and Ripening of Pears from Rogue River Valley. Ore. Exp. Sta. Bul. 254, Aug 1929.

